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# *Indian Standard*
# METHOD FOR CORROSION PROTECTION TESTS FOR TEMPORARY CORROSION PREVENTIVES

UDC 620·193

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 *August* 1983

# *Indian Standard*
# METHOD FOR CORROSION PROTECTION TESTS FOR TEMPORARY CORROSION PREVENTIVES

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( *Continued on page* 2 )

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# *Indian Standard*

# METHOD FOR CORROSION PROTECTION TESTS FOR TEMPORARY CORROSION PREVENTIVES

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 21 February 1983, after the draft finalized by the Corrosion Protection Sectional Committee had been approved by the Structural and Metals Division Council.

**0.2** The test described in this standard are intended to apply to various types of temporary corrosion preventives except volatile corrosion inhibitors (powder and paper). These tests are suitable for testing the effectiveness of temporary corrosion preventives applied to bare steel or composite metal surface. Salt spray tests may also be used for testing of temporary corrosion preventives ( *see* IS : 5528-1968*, IS : 6910-1973† and IS : 9844-1981‡ ).

**0.3** The humidity cabinet test and the sulphur dioxide test ( IP test ) give reasonable correlation with service performance under outdoor as well as indoor atmospheric conditions, but they are essentially accelerated corrosion tests and do not reproduce all the factors involved in the natural deterioration of the preventives. It will be preferred if the temporary corrosion preventives are evaluated by these tests against similar materials of known practical performance.

**0.4** Laboratory work has shown that the IP test, developed by the Institute of Petroleum, London, gives more reproducible results than the humidity cabinet test. Moreover, the results of the IP test ( without $SO_2$ ) have better correlation with actual exposure conditions than with the results of the humidity cabinet test. A further advantage of using the IP test is that marine, industrial or marine-cum-industrial conditions can be simulated in the IP test, whereas it is not possible in case of the humidity cabinet test.

**0.5** Test duration for each test against individual protective is generally given in the relevant material specification. However, in view of the wide variety of available protectives and of conditions of exposure in practice, it is better for the users of the specification to adopt a minimum test duration to a specified degree of breakdown, depending upon their individual requirement.

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*Method of testing corrosion resistance of electroplated and anodized aluminium coatings by copper-accelerated acetic acid salt spray ( CAS ) test.

†Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by acetic acid salt spray test.

‡ Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by neutral salt spray test.

**0.6** Temporary corrosion preventives and subsequent packaging must necessarily be considered together. It is known that the protectives behave differently in severe climatic conditions, depending on whether they are exposed in unpackaged or packaged condition.

**0.7** In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

## 1. SCOPE

**1.1** This standard prescribes various methods of testing the corrosion preventing efficacy of temporary corrosion preventives under set corrosive conditions to determine whether a desired standard of quality is achieved.

**1.2** The test shall be carried out on the following:

a) Standard test specimens, as defined in Appendix A, coated with a protective scheme under actual production conditions.
b) Actual articles, which are small enough to be exposed inside the testing chambers or apparatus.

**1.3** An indication of the types of protectives, to which the tests may be applied is given in Appendix B. The use of the tests for any particular purpose and the standard of performance required for such purpose are left to the discretion of those wishing to apply the standard.

**1.4** For certain uses, the ability of a protective to prevent corrosion, when in the damaged condition is important. Provision is made, therefore, for the test specimen to be subjected, if desired, to a standard form of damage, before they undergo test.

## 2. TEST FOR PROTECTION AGAINST CORROSION AT HIGH TEMPERATURE AND HIGH HUMIDITY ( HUMIDITY CABINET TEST )

### 2.1 Apparatus

**2.1.1** *Humidity Cabinet* — The humidity cabinet shall fulfil the following requirements:

a) *Humidification* — Condensation conditions shall be maintained by evaporation of distilled water from a small reservoir placed inside

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*Rules for rounding off numerical values ( *revised* ).

the cabinet (contamination of the internal water reservoir with oil or protectives may lead to the formation of a film on the surface of the reservoir. This reduces the volatilization of the water and hence the humidity of air in the cabinet);

b) *Heating* — The heating shall be done through the medium of water either by means of heaters placed immediately below the water reservoir or by a heater completely immersed in water;

c) *Temperature Cycle* — The heater shall be controlled in such a way that the temperature of the cabinet cycles continuously from 42 ± 1°C to 48 ± 1°C and back to 42 ± 1°C in not less than 45 min and not more than 75 min. The time required for heating and cooling shall be approximately equal;

d) *Air Circulation* — The air shall be circulated by means of a fan in such a way that the temperature in any part of the air space in the cabinet shall not differ from that in any other part by more than 0·5°C; and

e) *Spacing of Test Panels* — The panels may be supported on glass or plastic racks or suspended with the help of hooks made of glass or nichrome wire.

## 2.2 Material

**2.2.1** *Mild Steel Panels* — The mild steel panel required for this test shall be as specified in Appendix A. The size of panel shall be approximately 100 × 150 mm with a 3 mm diameter hole drilled centrally near one of the shorter edges.

**2.2.2** *Emery Cloth No. 1*

**2.2.3** *Emery Cloth No. 0*

**2.2.4** *Toluene, Sulphur-free or Acetone*

**2.2.5** *Methanol*

**2.3 Preparation of Mild Steel Panels** — The test panels shall be prepared according to instruction given in Appendix A.

**2.4 Application and Draining of Corrosion Preventives** — The temporary corrosion preventive shall be applied to the test panels by dipping, brushing or smearing, depending on the nature of the preventive. After dipping only once, the panels shall be suspended from their holes with the help of hooks made of glass or nichrome wire, for 24 hours in a vertical position at room temperature in a well-ventilated position and away from direct sunlight.

## 2.5 Procedure

**2.5.1** The test shall be run in quadruplicate.

**2.5.2** The coated panels shall be maintained vertically for specified time ( which may differ with the type of preservative ) in the humidity cabinet, after which the film of the material shall be removed from the panel by swabbing with a piece of muslin cloth soaked with toluene or acetone and the exposed metal visually examined for corrosion. The panel may afterwards be derusted to determine the loss of weight due to corrosion for comparative studies.

**2.5.3** *Acceptability Criteria* — The temporary corrosion preventive shall be taken to have satisfied the requirements of the test if three out of four panels do not show any sign of corrosion. Any corrosion extending up to 6 mm from the edges and the suspension hole, and also any corrosion due to local removal of the film of the corrosion preventive by the supporting device shall be ignored.

## 3. TEST FOR FREEDOM FROM CORROSIVE EFFECT ON METAL COUPLES

### 3.1 Apparatus

**3.1.1** *Oven* — The oven shall be thermostatically controlled and capable of maintaining a temperature of 50 ± 1°C.

**3.1.2** *Glass Container* — Four suitable wide-mouthed heat resistant glass containers fitted with vented corks shall be used.

### 3.2 Material

**3.2.1** *Test Panels* — The test panels of 50 × 25 mm shall be of mild steel, brass, aluminium alloy, magnesium alloy and zinc base alloy, whose compositions are described in Appendix A.

**3.2.1.1** The pair of metals concerned (*see* Appendix A) shall be drilled centrally to accommodate a nut and bolt which shall be of brass, except in the case of aluminium alloy and mild steel couple, when a steel nut and bolt shall be used. The pair of metals shall be clamped firmly together in the form of a cross with an angle of 20° between their major axes before test.

**3.2.2** *Emery Cloth No. 0*

**3.2.3** *Toluene, Sulphur Free or Acetone*

**3.2.4** *Methanol*

**3.3 Cleaning of Metal Panels** — All the metal panels shall be cleaned, finished and degreased as described in Appendix A.

### 3.4 Procedure

**3.4.1** The test shall be run in quadruplicate.

**3.4.2** Take sufficient quantity of temporary corrosion preventive in each of the four glass containers and introduce one metal couple in each of the containers such that half the length of the metal couple is immersed in the corrosion preventive. Close the glass containers with the vented cork and place them in the oven maintained at 50 ± 1°C for 8 h. Remove the glass containers from the oven and take out the metal couples from the containers. Separate the metal panels of the couple. Remove the film of temporary corrosion preventive by swabbing the metal panels with a piece of muslin cloth soaked in toluene or acetone and visually examine for corrosion.

## 4. COPPER STRIP CORROSION TEST

### 4.1 Apparatus

**4.1.1** *Test Tube* — Test tube made of resistant glass, size 25 mm dia × 150 mm length.

**4.1.2** *Beaker*

a) One tall form, made of resistant glass and of 100 ml capacity; and
b) One tall form made of resistant glass and of 150 ml capacity.

**4.1.3** *Low Pressure Bomb* — shall be of welded construction and made of stainless steel according to the dimensions given in Fig. 1. The bomb shall be used for working pressure up to 7 kgf/cm$^2$. Alternate designs for the bomb cap and the synthetic rubber gasket may be used but the internal dimensions of the bomb shall be the same as those shown in Fig. 1. One test tube shall be used as a liner for holding the sample.

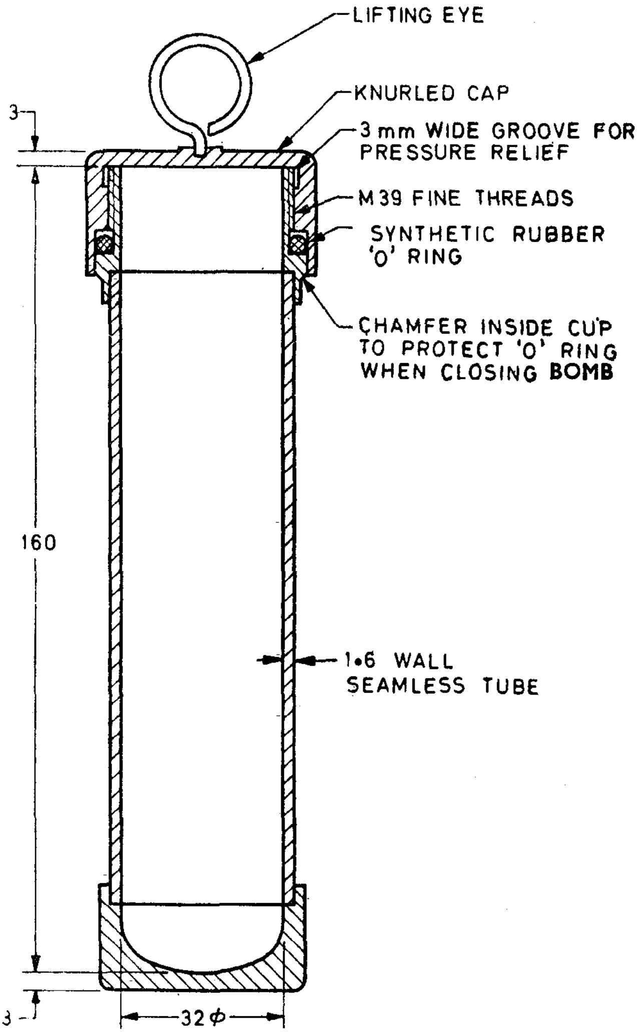
**4.1.4** *Bomb Bath* — An oil or water bath deep enough to completely submerge the bomb vertically and capable of being maintained at 100 ± 1°C.

**4.1.5** *Test Tube Bath* — An oil or water bath for maintaining a constant temperature of 100° ± 1°C or 50 ± 1°C. The bath shall be provided with support to hold the tube vertically and submerge to a depth of about 100 mm.

**4.1.6** *Oven* — The oven shall be able to be controlled within ± 2°C of the specified test temperature.

**4.1.7** *Thermometer* — conforming to the following requirements:

| | |
|---|---|
| Range | 20°C to 102°C |
| Graduation | 0·2°C |
| Immersion | Total |
| Over-all length | 406 ± 10 mm |
| Stem diameter | 6 to 8 mm |


LIFTING EYE
KNURLED CAP
3 mm WIDE GROOVE FOR PRESSURE RELIEF
M39 FINE THREADS
SYNTHETIC RUBBER 'O' RING
CHAMFER INSIDE CUP TO PROTECT 'O' RING WHEN CLOSING BOMB
1·6 WALL SEAMLESS TUBE
3
160
3
32 ϕ

All dimensions in millimetres.

FIG. 1 LOW PRESSURE BOMB

| | |
|---|---|
| Bulb shape | Cylindrical |
| Bulb length | 14 to 18 mm |
| Bulb diameter | 6 to 7 mm and not greater than stem |
| Length of graduated portion | 308 to 363 mm |
| Distance between bottom of bulb and 20°C mark | 32 to 51 mm |
| Longer lines at each | 1°C |
| Figured at each | 2°C |
| Expence chamber | To allow heating to 150°C |
| Top finish | Ring |
| Scale error not to exceed | ± 0·1°C |

**4.1.8** *Strip-Vice* — for holding the copper strip firmly without marring the edges while polishing. A small commercial vice may be adopted for this use by fitting it with stainless steel shields.

**4.1.9** *Flat Inspection Tube* — for protecting corroded strip for close inspection. This tube shall be free from stress or similar defects. The maximum dimensions of the inspection tube shall be as shown in Fig. 2 and the minimum shall be such that a copper strip 3·2 × 15 mm may enter easily.

**4.2 Materials**

**4.2.1** *Wash Solvents* — Use knock-test grade iso-octane or sulphur free toluene.

**4.2.2** *Water Distilled Quality* ( *see* IS : 1070-1980* )

**4.2.3** *Polishing Material* — silicon carbide or alumina grit paper or cloth of varying fineness down to No. 00 emery cloth or equivalent, also a supply of No. 150 grade carborundam powder and pharmaceutical grade absorbent cotton wool.

**4.2.4** *Copper Strips* — Strips of 75 mm in length, shall be cut from 13 mm wide, 1·6 to 3·2 mm thick, soft annealed copper strip made of electrolytic copper of not less than 99·9 percent purity. The strips may be used repeatedly but shall be discarded when they show pitting or deep scratches, which are not easily removable or when the surface becomes deformed.

**4.2.5** *Corrosion Standards* — ASTM Copper corrosion standard plaques. These consist of reproductions of typical strips representing increasing

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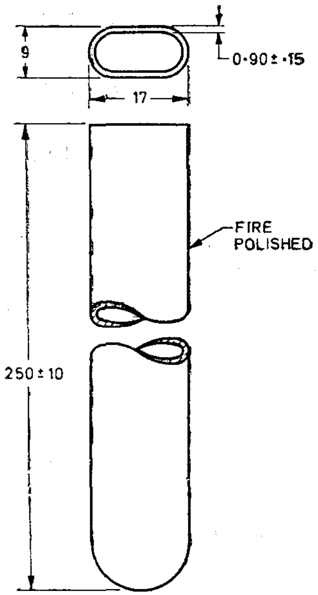
*Specification for water for general laboratory use ( *third revision* ).



All dimensions in millimetres

FIG. 2 COPPER STRIP VIEWING TUBE

degree of tarnish and corrosion, as described in Table 1 of IS : 1448 [ P : 15 ]-1976*. Suitable precautions shall be observed while handling the plaques. Keep the plastic encased printed copper corrosion standards protected from light to avoid possibility of fading. Inspect the fading by comparing two different plaques, one of which has been carefully protected from light (new). Observe both sets in diffused light ( or equivalent ), first from a position directly above and then from an angle of 45°. If any evidence of fading is observed, particularly at left hand end of the plaque, discard the one that is more faded than the other.

NOTE — Alternatively place a 20 mm opaque strip ( masking tapes ) across the top of the coloured portion of plaque when initially purchased. At intervals remove the opaque strip and observe. If there is any evidence of fading of the exposed portion, replace with a new plaque.

If the surface of the plastic cover shows excessive scratches, the plaque may be replaced.

### 4.3 Preparation of the Strips

4.3.1 *Surface Preparation* — Remove all surface blemishes from all six sides of the strip with silicon carbide or suitable alumina grit paper. Finish

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*Method of test for petroleum and its products : [ P : 15 ] Detection of copper corrosion from petroleum products by the copper strip tarnish test ( *second revision* ).

with 00 emery cloth or equivalent, removing all marks that have been made by the other grades of paper used previously. Immerse the strip in wash solvent from which it may be withdrawn immediately for final polishing or in which it may be stored for future use.

As a practical manual procedure for surface preparation, place a sheet of the abrasive paper on a flat surface, moisten it with kerosene or wash solvent and rub the strip against the paper with a rotary motion, protecting the strip from contact with fingers with an ashless filter paper. Alternatively, the strip may be prepared by motor driven machines using appropriate grades of dry paper or cloth.

**4.3.2** *Final Polishing* — Remove the strip from the wash solvent. Holding it in the fingers protected with an ashless filter paper, polish first the ends and then the sides with the 150 grade carborundum powder, picked up from a clean glass plate with a pad of cotton wool and moistened with a drop of wash solvent. Wipe vigorously with fresh pads of cotton and subsequently handle only with stainless steel forceps.

**4.3.2.1** *Caution* — Do not touch with fingers. Clamp in a vice and polish the main surfaces with the carborundum powder on cotton pad. Rub in the direction of the long axis of the strip carrying the stroke beyond the end of the strip before reversing the direction. Clean all metal dust from the strip by rubbing vigorously with clean pads of cotton until a fresh pad remains unsoiled. When the strip is clean, immediately immerse it in the sample.

**4.3.2.2** It is important to polish the whole surface of the strip uniformly to obtain a uniformly polished strip. If the edges show wear ( surface elleptical ), they are likely to show more corrosion than the centre. The use of a vice facilitates uniform polish.

## 4.4 Procedure

**4.4.1** *Test at 50°C for Samples Containing Less Volatile Matter* — Place 30 ml of sample, completely clean and free of any suspended or entrained water, into a chemically clean, dry test tube, as specified in **4.1.1** and within 1 minute, after completing the final polishing, slide the copper strip into the sample tube. Stopper it with a vented cork and place in a bath maintained at the required temperature. Protect the sample from light during test. After 3 hours ± 5 minutes in the bath, take out and examine the strips as described in **4.5**.

**4.4.2** *Test at 100°C for Volatile Material* — Take 30 ml of sample in the test tube and slide the copper strip into the test tube as before. Carefully slide the test tube into the sample bomb, specified in **4.1.3** and screw the lid tight. Completely immerse the bomb in an oil or water bath specified in 4.1.4. After 2 hours ± 5 minutes in the bath, withdraw the bomb and immerse for a few minutes in tap water. Open and withdraw the test tube and examine the strips as described in **4.5**.

**4.5 Examination of the Copper Strip** — Empty the contents of test tube (containing liquid sample) into a 150 ml tall-form beaker, letting the strip slide in gently so as to avoid breaking the beaker. Immediately withdraw the strip with stainless steel forceps and immerse in a wash solvent. Withdraw the strip at once, dry with suitable filter paper ( by blotting and not by wiping ).

**4.5.1** Inspect for evidence of tarnishing or corrosion by comparing it with ASTM Copper Strip Corrosion Standards. Hold both the test strip and the standard strip in such a manner that light reflected from them at an angle of approximately 45° is observed. The danger of marking or staining will be avoided if the strip is inserted in the inspection tube, which is stoppered with absorbent cotton.

**4.6 Interpretation** — Interpret the corrosiveness of sample accordingly as the appearance of test strip agrees with one of the strips of ASTM Copper Strip Corrosion Standards. When a strip is in the obvious transition stage between that indicated by any two adjacent corrosion standard strips, judge the sample by the more tarnished standard strip [*see* Table 1 of IS : 1448 [ P : 15 ]-1976*.

**4.6.1** To distinguish multi-coloured strips, place the strip in a 20 × 150 mm test tube and bring it to a temperature of 315 to 370°C in 4 to 6 minutes with the tube lying on a hot plate. Now judge the strip by comparing with the standard strips.

## 5. TEST FOR CORROSIVE EFFECT ON LEAD

### 5.1 Apparatus

**5.1.1** *Oven* — The oven shall be thermostatically controlled and capable of maintaining a temperature of 50 ± 1°C.

**5.1.2** *Glass Container* — A wide mouthed glass container, fitted with ground glass stoopper, shall be used. Its capacity shall be approximately 500 ml and shall be made from heat resistant glass.

### 5.2 Materials

**5.2.1** *Lead Test Panels* — The composition of the metal shall be as described in Appendix A.

The panel shall be approximately 75 × 50 × 1·6 mm in size and shall be free from deep scratches and surface imperfections.

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*Methods of test for petroleum and its products [P : 15] Detection of copper corrosion from petroleum products by the copper strip tarnish test (*second revision*).

5.2.2 *Toluene, Sulphur-free or Acetone*

5.2.3 *Methanol*

5.2.4 *Dilute Acetic Acid* — Approximately one percent by volume.

**5.3 Cleaning of Lead Panel** — The panel shall be cleaned, finished and degreased as described in Appendix A.

**5.4 Procedure**

5.4.1 Carry out the test in triplicate.

5.4.2 Place the weighed lead panel in the glass container and add sufficient quantity of the corrosion preventive so that the panel is immersed to a depth of 10 mm below the surface of the corrosion preventive. Close the container with the stopper and place it for 8 hours in the oven maintained at 50±1°C. Remove the container from the oven, withdraw the panel and cool. Remove the film of corrosion preventive by swabbing lightly with cotton wool soaked in toluene or acetone. Dip the panel in boiling acetic acid for 1 to 2 minutes, rinse with water, dry and weigh. Carry out, side by side, one or two blank tests by dipping for the same period of time, fresh panels of lead in boiling dilute acetic acid of the same strength. Rinse with water, dry and determine the loss in weight of the panel. Substract the loss in weight, as obtained with the blanks, from that of the assay test panels to get the correct loss in weight of the latter.

5.4.2.1 Calculate the average loss in weight of the panel in milligrams per square centimetre of surface. Report the average of three results.

## 6. TEST FOR CORROSION RESISTANCE OF STRIPPABLE COATINGS

**6.1 Apparatus**

6.1.1 *Ovens* — Thermostatically maintained at the desired temperature.

6.1.2 *Humidity Cabinet* — Suitably designed so that a relative humidity of 100 percent is maintained by evaporation of water from a reservoir situated at the bottom. The water shall be heated by a heater completely immersed in the water. The temperature of the air space shall be controlled thermostatically so that it lies between 40 and 42°C the air space in the cabinet shall be maintained at a uniform temperature within ± 5°C at any point by means of a suitable air-circulating fan.

6.1.3 *One Glass Beaker* — for melting the material, one litre capacity.

6.1.4 *Sodium Chloride Solution (5 percent)* — Dissolve 5 g of sodium chloride, pure grade, in 100 ml of distilled water.

### 6.2 Materials

**6.2.1** *Steel Panels* — 75 × 50 × 3 mm size made from cold finished steel with rounded edges and corners each having a 5 mm hole with its centre in the middle of its length and at a distance of 5 mm from one long edge. Each panel shall be provided with a suitable suspension wire of copper passing through the hole. Each panel shall be polished, finished and degreased as described in Appendix A. Before use, each panel shall be kept in a desiccator for one hour.

### 6.3 Resistance to High Humidity

**6.3.1** *Procedure* — Cut about 600 g of materials in 6·25 mm size cubes and place them in one litre glass beaker. Heat it in an oven at the specified dipping temperature within ±2°C. Suspend 3 steel panels into the molten compound for a period of about 5 seconds. Dip twice. Remove the panel quickly without jerks and allow it to drain without shaking it or giving it any jerky motion. Keep the panels at room temperature for about 2 hours. Keep the panels for 72 hours in the humidity cabinet maintained at 42 to 45°C.

**6.3.1.1** After this period take out the panels carefully, strip off the film and examine them. The material shall be regarded as resistant to high humidity if the panels show no evidence of corrosion.

### 6.4 Resistance to Temperature Cycling

**6.4.1** *Procedure* — Coat three steel panels described in **5.2.1** but keep them at room temperature for about 24 h. Subject the panels to the following cycle 5 times:

a) 16 hours in the humidity cabinet;

b) Three hours at a temperature of —10±1°C;

c) Two hours at a temperature of 10±1°C; and

d) Three hours immersion in a 5 percent sodium chloride solution at room temperature.

**6.4.1.1** After completing the 5 cycles, take out the panels, carefully strip off the film and examine them. The material shall be regarded as resistant to temperature cycling, if panels show no evidence of corrosion.

## 7. SULPHUR DIOXIDE TEST (IP TEST)

### 7.1 Apparatus

**7.1.1** *Beaker* — of resistant glass, without spout, of 5 litre capacity, approximately 270 mm high and 170 mm outside diameter and fitted with a rubber gasket to take the cover.

**7.1.2** *Beaker Cover* — dome-shaped of unplasticized methyl methacrylate plastic ( Perspex ) material, kept in position by a suitable rim or groove, and having three 16 mm holes centred along one diameter of the cover, with one at its centre and other two at 70 mm radius.

**7.1.3** *Thermostat Holder* — a resistant glass test tube supported in the centre hole of the cover. This test tube also acts as a support for the panel holder, which is held in place by a stout rubber ring. A piece of rubber tubing, 11 mm bore, 5 mm wall thickness, about 38 mm long, has been found suitable for this purpose.

**7.1.4** *Panel Holder* — of unplasticized methyl methacrylate plastic material capable of supporting twelve panels radially in the beaker. Alternative designs are permissible provided the positions of the panels are identical.

**7.1.5** *Heater* — electrical, automatically controlled to maintain the specified test temperature, contained in a support that has recess 58 to 64 mm deep in which the beaker sits, the clearance between the beaker and the wall of the recess being approximately 2·5 mm. ( It has been found that a heater of 150 W, so arranged that 50 W is continuously on and 100 W is controlled by the thermostat is suitable ).

**7.1.6** *Thermostat* — capable of controlling the heater to maintain the temperature of the air space between 42 to 48°C and placed in its holder so that it is 25 mm above the bottom edge of the panels when they are in position.

**7.1.7** *Water Cooling Device* — coiled compo or soft-metal tubing ( 8 mm dia ) resting on the top of the recess, the number of turns of the coil being such that the top of the coil is 6·0 to 6·5 mm below the level of the top of the panels.

**7.1.8** *Thermometer* — conforming to IS : 4825-1968* and inserted in one of the holes in the cover so that the bulb is in level with the mid-point of the panels.

### 7.2 Materials and Reagents

**7.2.1** *Steel Panels* — 150 × 50 × 0·9 mm thick mild steel as described in Appendix A.

**7.2.2** *Emergy Cloth* — Grade 0 and 1.

**7.2.3** *Sodium Thiosulphate* — solid.

**7.2.4** *Sulphuric Acid* — pure grade, 0·15 to 0·16 N.

**7.2.5** *Petroleum Hydrocarbon Solvent* —60 to 80 grade ( *see* IS : 1745-1978† ). As an alternative, n-heptane may be used.

**7.2.6** *Derusting Solution for Mild Steel* —same as described in Appendix A.

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*Specification for laboratory and reference thermometers.

†Specification for petroleum hydrocarbon solvents ( *second revision* ).

### 7.3 Procedure

**7.3.1** Prepare and finish mild steel panels as described in Appendix A. Coat three panels with each preventive under test. If desired the specimens may be damaged by making two longitudinal scratches each 40 mm long, with a point of knife-head.

**7.3.2** Pour into the beaker 500 ml of distilled water in which 50 g of sodium thiosulphate has been dissolved. Assemble the test panels coated with the temporary corrosion preventive and two similar uncoated, weighed panels on the holder. Place the cover on the beaker and adjust the panel holder so that the lower edges of the panels are approximately 40 mm from the surface of the thiosulphate solution. Switch on the current and run cold water through the cooling coil. When the vapour temperature has stabilized at approximately 45°C, add 10 ml of sulphuric acid; this corresponds to 0·05 g of sulphur dioxide. Add a further quantity of 10 ml of acid after approximately 8 hours and additional 10 ml quantities twice in each working day at intervals of approximately 8 hours, except during the fifth and sixth days. Make these additions from a small graduated cylinder through a long stemmed funnel to avoid splashing the panels. Except when adding the acid, close the holes in the lid with rubber bungs during the test. Turn each panel through 180° about its vertical axis every 25 hours except on the fifth and sixth days and the whole set of panels through 90° after each addition of acid. Continue the test for the agreed period. In case where test is to be conducted without $SO_2$, additions of sulphuric acid will not be made. The other procedure will remain the same.

**7.3.2.1** At the end of the test period, remove the panels from the beaker, wash off the corrosion preventive with the petroleum solvent, and derust with Clarks solution ( *see* Appendix A ).

**7.4 Loss in Weight of Control Specimens**—At the end of the agreed test period the loss in weight of the control specimens shall be determined after derusting as described in Appendix A. The average loss in weight in case of testing with $SO_2$, shall be not less than the value given below:

| *Test Duration days* | *Average Loss in Weight of 150×50 mm Mild Steel Test Panel, g* |
|---|---|
| 1 | 0·5 |
| 3 | 1·0 |
| 5 | 2·0 |
| 7 | 2·2 |
| 14 | 3·6 |
| 21 | 4·1 |
| 28 | 5·8 |

**7.5 Inspection**

**7.5.1** At the end of the agreed test period, the specimens shall be rinsed in cold water, visually inspected and allowed to dry at room temperature. The film of the applied temporary preventives is removed by swabbing with the petroleum solvent and final inspection is made.

**7.6 Number of Test Specimens**

**7.6.1** Test shall be made on three test panels coated with each preventive under test. At the end of the agreed test period, no specimen shall fail to comply with the criteria specified in **7.7**.

**7.7 Criteria of Acceptability** — For acceptance of the temporary corrosion preventive, there shall be not more than 0·5 percent ( by area ) of rust and rust-staining in case of undamaged test specimens.

In case of damaged test specimens, no rust or rust-staining shall extend at any point beyond 5 mm from the original boundaries of scratches.

## APPENDIX A

( *Clauses* 1.2, 2.2.1, 2.3, 3.2.1, 3.2.1.1, 3.3, 5.2.1, 5.3, 6.2.1, 7.2.1, 7.2.6, 7.3.1, 7.3.2.1 *and* 7.4 )

## STANDARD TEST SPECIMENS AND THEIR PREPARATION

### A-1. SPECIMENS

**A-1.0** Rectangular metal panels, cut from bright sheet or strips, preferably of 0·9 to 1·25 mm thickness ( except for lead and magnesium ) shall be used in the tests.

### A-1. COMPOSITION OF METALS

**A-1.1** The test specimens shall be prepared from the following types of metal sheets:

a) Mild steel sheets of extra deep drawing quality having a bright finish and in the fully annealed condition conforming to IS : 513-1973*.

b) Electrolytic copper sheets in the soft annealed condition having a minimum purity of 99·9 percent.

c) Brass sheets of alloy CuZn40 conforming to IS : 410-1977†.

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*Specification for cold-rolled carbon steel sheets ( *second revision* ).

†Specification for cold-rolled brass, sheet, strip and foil (*third revision* ).

d) Zinc base alloys conforming to IS : 713-1981*.

e) Aluminium alloy sheets of alloy 24345 conforming to IS : 737-1974†.

f) Pure lead sheets conforming to IS : 405 ( Part I )-1977‡.

g) Magnesium alloy sheets having the composition, as given below:

| *Constituent* | *Percent by Weight* |
|---|---|
| Aluminium, *Max* | 0·05 |
| Zinc, *Max* | 0·03 |
| Manganese, *Max* | 1·0 to to 2·0 |
| Copper, *Max* | 0·02 |
| Silicon, *Max* | 0·02 |
| Iron, *Max* | 0·03 |
| Nickel, *Max* | 0·005 |
| Calcium, *Max* | 0·02 |
| Magnesium | Remainder |

**A-1.2** A suspension hole, about 6 mm in diameter and lightly counter sunk on each side, shall be drilled centrally at 6 mm distance from the edge of one of the shorter side, if the test specimens are to be suspended. All cut edges and corners shall be slightly rounded off and smoothed. Panels shall be free from scales or oxides, pits, scratches or surface imperfections.

## A-2. SURFACE PREPARATION OF TEST SPECIMENS

**A-2.1 Mild Steel, Copper, Brass and Zinc Alloys** — Abrade the panels first with emery cloth No. 1 and then with emery cloth No. 0 finishing with circular motion until the surface is covered with circular polishing marks superimposed on each other. Finally polish them to a smooth bright finish.

**A-2.2 Magnesium Alloy** — Polish to a smooth finish with moist pumic powder.

**A-2.3 Aluminium Alloy** — Polish to a smooth finish with moist pumic powder.

**A-2.4 Lead Panel** — Clean the panel on both sides and on all edges to a smooth bright finish by scraping with a sharp tool. Then clean it by dipping in boiling 1 percent acetic acid solution for one minute.

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*Specification for zinc base alloy ingots for die castings ( *second revision* ).

†Specification for wrought aluminium and aluminium alloys sheet and strip ( for general engineering purposes ) ( *second revision* ).

‡Specification for lead sheet and strip: Part I For chemical industries ( *second revision* ).

## A-3. DEGREASING OF PANELS BEFORE TEST

**A-3.0** Clean and degrease the metal panels by swabbing with cotton or muslin cloth saturated with sulphur-free toluene ( *see* IS : 537-1967* ) or acetone ( sulphur free ).

Rinse the panel with methanol ( minimum 98 percent by volume and water white in colour, containing not more than traces of aldehydes and acids ). In case of magnesium alloy, dry methanol shall not be used. Finally, dry the panel in a current of warm, dry air and after weighing, immediately coat with the material. During and after degreasing, do not handle the panels by bare hands. Use a pair of clean metal forceps, preferably of stainless steel.

## A-4. WEIGHING OF PANELS

**A-4.1** Weigh the test specimens in a microbalance, if metal loss due to corrosion is to be ascertained, and record the weights.

## A-5. CLEANING OF TEST SPECIMENS AFTER TEST

**A-5.0** In most of the cases, there will be no need to clean the test specimens as observation of the condition of metal surface is considered sufficient. However, if the loss in weight data is needed, the test specimens should be cleaned as below.

### A-5.1 Mild Steel Test Specimens

**A-5.1.1** *Reagent — Clarke's Solution* — Dissolve 20 g of antimonious oxide and 50 g of stannous chloride in one litre of concentrated hydrochloric acid ( rd 1·16 ).

**A-5.1.2** *Procedure* — The specimens shall be immersed in Clarke's solution for derusting. The solution shall be cool ( at ambient temperature ) and the test specimens kept moving in it until derusting is complete. The specimens shall then be washed in cold running water, dried between filter papers or by hot air, kept in a desiccator, and weighed. The figure to be recorded is the difference between the weight of the freshly degreased specimens and the corresponding weight after derusting.

It is essential that the specimens be kept moving in the solution so as to ensure rapid reduction of ferric chlorides produced by solution of the rust, otherwise attack on the steel itself may occur.

### A-5.2 Brass and Copper Test Specimens

**A-5.2.1** *Reagent—Sulphuric Acid Solution* — ( *5 Percent v/v* ) — Dissolve 5 ml of concentrated sulphuric acid ( rd 1·98 ) in 95 ml of distilled water.

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*Specification for toluene, pure, nitration grade ( *first revision* ).

**A-5.2.2** *Procedure* — Dip the test specimen for 30 seconds to 5 minutes in sulphuric acid solution at room temperature till the metal surface becomes free from corrosion product. Wash in cold running water, dry and weigh.

### A-5.3 Aluminium Alloy Test Specimen

**A-5.3.1** *Reagents*

a) *Concentrated nitric acid* ( *rd* 1·12 ).

b) *Chromic acid — phosphoric acid* — Dissolve 2 g of chromium trioxide ( free from chloride ) and 5 ml of phosphoric acid in 100 ml of distilled water.

**A-5.3.2** *Procedure* — Immerse the test specimen for 30 seconds to 2 minutes in concentrated nitric acid at room temperature until corrosion product on the surface dissolves away. Wash in running water, dry and weigh. If the corrosion product does not dissolve, dip the panel in chromic acid and phosphoric acid solution at 80-85°C, wash in running water, dry and weigh.

### A-5.4 Magnesium Alloy Test Specimens

**A-5.4.1** *Reagent — Chromic Acid Solution* — Dissolve 15 g of chromic oxide and 1 g of silver chromate in 100 ml of distilled water.

**A-5.4.2** *Procedure* — Dip for 5-15 minutes in boiling chromic acid solution, till the surface is free from corrosion product. Wash in water, lightly scrubbing with soft bristle brush, dry and weigh.

### A-5.5 Zinc Alloy Test Specimen

**A-5.5.1** *Reagent — Chromic Acid Solution* — Dissolve 10 g of chromic oxide and 2 g of silver chromate in 100 ml of distilled water.

**A-5.5.2** *Procedure* — Dip for 5-10 minutes in the solution at ambient temperature, till the surface is free from the corrosion. Wash in water, lightly scrubbing with soft bristle brush, dry and weigh.

### A-5.6 Lead Test Specimen

**A-5.6.1** *Reagent — Dilute Acetic Acid* — Mix 1 ml of glacial acetic acid with 100 ml of distilled water.

**A-5.6.2** *Procedure* — Dip the panel in the boiling dilute acetic acid for 1-2 minutes, rinse with water and dry.

NOTE — Clean one control specimen ( uncorroded ) under same conditions in each case. Determine its loss in weight and deduct this figure from the obtained loss in weight of the test specimen.

# APPENDIX B

( *Clause* 1.3 )

## TYPES OF TEMPORARY PROTECTIVES

### B-1. HARD FILM SOLVENT DEPOSITED TYPE — DIPPING OR SPRAYING

**B-1.1** It consists of solutions of protectives. It is generally applied by dipping or spraying, for example, plasticised resins in volatile solvents. On evaporation of the solvent, a thin, tough, abrasion-resistant film, capable of being handled without damage, is obtained. Quick drying and slow drying materials are available. Primary warp of waxed paper is necessary to protect mechanical damage in transportation and handling.

### B-2. SOFT FILM SOLVENT DEPOSITED TYPE — COLD DIPPING OR SPRAYING

**B-2.1** It consists of solutions of protectives like lanolinds in volatile solvent and is applied by dipping or spraying. On evaporation of the solvent, a thin soft film of protective remains on the metal surface.

There are two grades:

a) Ordinary grade, and

b) Water displacing grade.

### B-3. SOFT FILM, HOT DIPPING TYPE

**B-3.1** It gives a thick soft film of a protective, usually based on petrolatum ( petroleum jelly or mineral jelly ). It is applied by dipping in melted protective.

### B-4. SOFT FILM GREASE

**B-4.1** It is normally applied by brushing or smearing to give a thick soft film. There are two grades:

a) Conventional type-metallic soap mineral oil base grease, and

b) Castor oil base grease.

### B-5. SOFT FILM, SEMI FLUID TYPE

**B-5.1** It is based on solutions of suitable corrosion inhibitors ( for example wool fat derivatives ) in mineral oils or in mixtures of mineral oils and petrolatum gives films of medium thickness and is applied by brushing or swabbing.

## B-6. OIL FILM TYPE

**B-6.1** It consists of lubricating oils containing soluble corrosion inhibitors. These are generally applied by dipping, spraying or brushing. There are two grades:

a) Oil type—general purpose protectives; and

b) Oil type engine protectives.

## B-7. STRIPPABLE COATING

**B-7.1** It forms tough, impermeable films, which can readily be stripped from the protected article. There are two grades:

a) Strippable hot dip coating consists of ethyl cellulose, small amounts of mineral oil together with plasticisers, resins and stabilizers.

b) Strippable coating, cold applied — consists of protectives, for example vinyl copolymer resins, plasticizers and stabilisers in flammable or non-flammable solvents.

It is applied by dipping, spraying, or brushing.